APPENDIX B.1. REARING FACILITIES
- ALTERNATIVE AND PROPOSED PLAN EVALUATIONS
Yakama Nation Fisheries Resource Management

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I. *SUMMARY*

The Mid-Columbia Coho Restoration Program (MCCRP) alternatives for the rearing component of the project are evaluated and a proposed fish production plan is described. Guidelines are developed to support the selection of the basic types of systems and specific sites that would form the rearing plan. They are intended to support the main objective of producing quality pre-smolts that return to release areas in high numbers.

The rearing environment in which fish are cultured is critical to meeting the restoration goal. High quality juveniles can survive significantly better than fish reared in a compromised hatchery environment. The availability of the correct amount and quality of reliable water supplies and the capability of sites to include effective rearing units are important site requirements. Other siting guidelines involve construction and operating costs, the environmental impacts of construction and operation, the flexibility to meet changing needs, and operational considerations.

The different basic types of fish rearing system options evaluated include:

- Existing public hatcheries.
- A new, large, central hatchery.
- Several small rearing facilities located in the watersheds.
- A central hatchery using constructed, natural habitat.
- Extended rearing at acclimation sites.
- Constructed habitat.
- Combinations of the above.

Specific sites that could be used in these systems include existing Yakama Nation, US Fish and Wildlife Service, and Mitchell Act funded hatcheries; existing acclimation sites with long-term rearing capability; and locations that require new development and construction.

These production systems and sites were compared. Based on the comparison a preferred rearing plan is proposed. The plan places heavy emphasis on existing hatcheries due to cost considerations. Existing facilities will generate over 85% of MCCRP fish, with new facilities producing the remainder. A new, small facility with only adult holding and incubation capabilities is proposed for the Wenatchee basin. Fry to smolt production in constructed habitats is proposed for a portion of the Methow releases. This rearing plan, along with the MCCRP acclimation plan, will cost effectively produce smolts that will be capable of surviving to adulthood at rates that are expected to restore naturally producing coho in the Wenatchee and Methow basins.

Table 1. Proposed Production Plan Summary

	Location	Type	Fish
Wenatchee	Cascade	Existing Hatchery	250,000
	Willard	Existing Hatchery	905,000
Methow	Eightmile	Constructed Habitat	200,000
	Heath Ranch	Constructed Habitat	100,000
	Cascade	Existing Hatchery	450,000
	Winthrop	Existing Hatchery	250,000
TOTAL			**2,155,000**

II. *INTRODUCTION*

This appendix evaluates program rearing options. A rearing plan is selected from these options and is described in detail in appendices C.1 and C.2. The following is a list of master plan facility appendices, with this appendix highlighted.

A. FISH CULTURE GUIDELINES
B. ALTERNATIVE AND PROPOSED PLAN EVALUATIONS
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D. PROJECT SCHEDULE AND COSTS

Plans require the identification of facilities that will produce a maximum of 2155,000 coho pre-smolts by the year 2012 when the Natural Production Phase is implemented in both subbasins. This release number is expected to be the maximum production requirement and will be reduced after one generation, as natural smolt production increases.

Current releases are approximately 1,000,000 in the Wenatchee and 300,000 in the Methow. These fish are being produced as pre-smolts at the US Fish and Wildlife Service (USFWS) Willard National Fish Hatchery and the Oregon Department of Fish and Wildlife (ODFW) Cascade Fish Hatchery; and as smolts at the USFWS Winthrop National Fish Hatchery.

III. *SITING AND DESIGN GUIDELINES*

Rearing program design development requires two steps. The first is to determine what type of rearing system is to be used and the second is to select individual sites for the systems chosen. Guidelines are identified that support the evaluation of both basic systems and specific sites.

A. ADULT RETURN RATES

Rearing systems will have a large impact on the success of the MCCRP. See Appendix A, FISH CULTURE GUIDELINES for more detail and references). Evidence of the importance of rearing includes reports that show that naturally produced smolts survive at rates that can be several times higher than hatchery produced smolts. Literature also indicates that smolts reared in conditions that simulate natural conditions survive to adulthood at increased rates.

1. Rearing Environment

Optimal coho culturing conditions are described in Appendix A and summarized below. They have been selected based on literature reviews and discussions with fish culturists. The conditions include low rearing densities, large volume production units, natural water temperatures, limited fish transportation of fully smolted fish, low flow densities and limited predation. Specific culturing guidelines are proposed that provide those conditions:

- *First and second winter water temperatures*: 33 to 40 F.
- *Summer water temperature*: daily peak of 65 F and maximum daily average of 62 F.
- *Water pathogen load*: minimized for as long as possible, a priority for incubation and early rearing.
- *Maximum volume density*: 0.3 lb/cft for fish larger than 100/lb. 0.1 lb/cft for facilities with less reliable water supplies (acclimation sites).
- *Maximum flow density*: water temperature and fish size dependant, a maximum of 10 lbs/gpm for 20/lb fish in 50 F water. Safety factors reduce this value.
- *Main rearing units*: large ponds or constructed natural habitat for fish larger than 100/lb.
- *Trucking*: no movement after fish begin smolting (assumed to begin at a size larger than 40/lb in March). No transport between watersheds is preferred.
- *Acclimation period*: 6 or more months for sites that can function through the winter, 6 weeks for those that cannot.

2. Water Quantity and Quality

Facility locations will be chosen using the availability, reliability, and quality of water supplies as important criteria. Water parameters are critical for producing fish that not only have high egg-to-smolt survival rates but also high smolt-to-adult survivals (see Appendix A).

Water availability at potential sites in the late fall during low flow periods are important for surface supplies. Water requirements are greatest in the late summer, prior to transportation to acclimation sites, because the high water temperatures result in high metabolic rates.

The reliability of flow is critical. Site selection can reduce flow risk by identifying locations with water supply features that are described below. Facility design can also reduce this risk through back-up power generation, redundant delivery systems, and the use of large volume rearing units.

As discussed in Appendix A, the natural temperature profile of surface water helps produce quality fish. However, surface supplies have several potential problems that can result in water supply loss. These include: ice formation on intake screens, migration of stream channels away from intakes, and debris deposition on intakes during floods. Surface water intakes in deep pools, at a stable section of a stream channel, and with adequate sweeping velocities solve many of these problems.

Infiltration galleries are a water supply option that can be considered at some new sites. Infiltration galleries tap shallow water aquifers. With hydraulic connectivity to surface water, infiltration galleries have the advantage of more yearly and daily temperature fluctuation than water from deep aquifers and are easier to permit. Gallery construction is generally more expensive than wells because construction is more complex. The galleries must be correctly designed to avoid maintenance problems.

Dual water supplies reduce both reliability and quantity problems. Groundwater supplies do not suffer from the same intake vulnerability issues and low flow conditions that surface water supplies do. Sites that have groundwater supply capability, either in the form of deep wells or shallow infiltration galleries, were given higher priority.

Underground aquifers that yield the large quantities of water needed for fish culture are uncommon. Thick layers of high permeability material (clean gravel) well below the water table must be located. Several such aquifers in the Columbia basin have been identified, but are developed for public supplies and existing hatcheries. Continuous, large water withdrawals required by fish culture facilities can affect surrounding wells and siting must consider this potential impact.

Gravity flow for both surface and ground water is preferred. With gravity flow, the cost of development of water supplies, the risks due to mechanical or power failures, brown-outs, and operating costs are all reduced.

Water treatment can artificially produce desired water supply conditions. There are varying degrees of water conditioning; following is a list of treatment processes in increasing order of complexity, cost, and reliability:

- Temperature control during incubation and early rearing. Chillers can delay hatching and first feeding reliably yet cost effectively due to the low water requirements during these rearing stages.
- Re-use water through aeration. Simple aeration methods can cut water requirements by approximately one-half.
- Cooling ground water in winter and warming in summer using large impoundments. Natural water temperatures help produce high quality smolts (See Appendix A).
- Turbidity reduction. Primary settling of the incoming supplies can reduce the solids loads of surface supplies.
- Sterilization of incubation and early rearing water. Ozone, UV, or chlorination/dechlorination sterilization techniques can reduce the incoming fish pathogen load of surface water supplies. The techniques are most effective with supplies that have a low turbidity (groundwater or treated surface water).
- Temperature control during later rearing. Chillers and heaters can change rearing water temperatures, but the large flow volumes make this option expensive even when applied with re-use technology.
- Full re-use through aeration and ammonia removal. Water requirements can be reduced by up to 90% with bio-filtration and sterilization. These methods have high capital and operating costs and add elements of risk if sterilization is not effective or if mechanical systems fail.

The first choice for water supplies will be those that do not need altering or conditioning. Requiring the first bullet above, hatchery water chilling, will not be considered a major site drawback. Requiring the last, full water re-use, will be and such sites will have a low priority.

Water re-use without complex treatment is also possible. At hatcheries that use low rearing flow densities and/or have excess head that can be used for gravity flow with re-aeration in the water supply, the quality of second use water may be acceptable. Such water is routinely used in many existing hatcheries. The major disadvantage of re-use is disease transmission from the upstream population. This is minimized by low-stress rearing environments and good fish health practices. Flooding imposes a risk to both fish and facilities. Because of the dependence of rearing sites on the proximity of large streams, they are subject to flood damage. The option of building facilities above 100 year flood elevations is not always possible due to impacts that result from the reduction of flood storage capacity, imposing restrictions on siting. Future changes to the upstream watershed may change flood characteristics and should be considered as well.

3. Adaptability

Fish rearing technology has changed frequently over the past 80 years. Incubation systems, rearing units (Foster Lucas ponds, to Burroughs ponds, to flow through raceways, for example), feeding practices, etc. have all changed significantly. Sites should have the flexibility to adapt to future changes.

Choices of water supplies (ground and surface) should be available to future managers and the space for constructing new facilities should exist. Increasing (and decreasing) production levels and rearing other species are future possibilities. Sites that have excess water and space will have this capability.

B. COST

Both capital and operating costs are important evaluation considerations. In this appendix, average values of costs to construct and operate rearing facilities in the region are used to compare different systems (Appendices C.1 and C.2 estimate site specific costs for the proposed rearing alternative). The details of the cost estimating procedures used are listed in Attachment 4, CAPTIAL AND OPERATING COST BASIS.

C. OTHER

1. Environmental Impacts

The potential environmental impacts of proposed facilities will be reviewed in detail during the NEPA, ESA, and site permitting processes. The length of time, cost, and difficulty of obtaining the necessary construction and operating permits are important site selection considerations.

Surface water withdrawals impact streams for the distance between the removal and the return. Hatcheries are non-consumptive except in the withdrawal reach. Sites and designs that allow discharge to occur just downstream of the intake minimize impacts. Large-scale groundwater use can affect users within the cone of influence of the well or gallery. Due to these potential impacts, the new water rights permit application process for both supplies can be long and difficult.

The potential impact to listed species can change a site’s development status. Other environmental and permit considerations include local land use zoning codes, flood impacts, disease transmission from the hatchery to downstream fish populations (both in hatcheries and in the wild), cultural resources, and receiving water quality standards.

Mitigation for disturbance of wetlands is possible but expensive and requires a lengthy design review process. Also, the shoreline, zoning variance, and building permit processes can be difficult if there is local opposition to construction. Cultural resources and impacts to floodplain storage capacity need to be evaluated at all locations. A thorough review of potential environmental issues early in the site development process will be required at new facilities.

2. Operation

Proximity to other program facilities, especially acclimation sites, is also a consideration. Rearing facilities that are closer to acclimation sites will be given a higher priority.

Existing facilities that are operated by other agencies have both advantages and disadvantages. YN control and program flexibility are limited under these conditions in which hatchery personnel often follow different operating protocols. However, professional support from experienced staff can be a major asset provided by the other agencies.

3. Site Considerations

Large capital investments in rearing facilities require that property be usable for long periods. Property control can be obtained through purchase, long-term lease, or by legal agreement with public agencies.

Other site development concerns include the availability of power, environmental liability, and access. Three-phase power is required to operate water pumps, chillers, and other major motor driven machinery. Sites that have previously had other uses may have ground contamination, resulting in liability exposure. Access to remote sites in upstream areas may be limited by flooding and winter snow.

IV. *SYSTEM AND SITE ALTERNATIVES*

There are several rearing systems that can meet the MCCRP coho production requirements. "Systems" is used as a term for describing various general types of facilities and rearing methods. Each system has advantages and disadvantages which are evaluated in the first section below. Specific sites that can be used as components of these general rearing systems are identified in the section B.

A. PRODUCTION SYSTEM OPTIONS

Basic rearing systems are listed separately below in order to evaluate their strengths and weaknesses. However, a combination of the different systems is the proposed alternative selected (see Chapter V. RECOMMENDATIONS). Specific sites are chosen from lists in Section B of this chapter to help demonstrate how the rearing systems would operate.

The cost estimates shown in the following tables are developed using procedures outlined in the Attachment 4, CAPITAL AND OPERATING COST BASIS. They are based on recent hatchery construction projects and on current facility operating cost data. These estimates do not include other components of the program: brood capture, acclimation (for most rearing system options), and monitoring and evaluation.

1. Descriptions

a. Existing Public Hatcheries

This system option makes use of hatcheries with existing capacity. Most of these facilities are located along the lower Columbia River near or below Bonneville Dam: Washougal, Cascade, Eagle Creek, and Willard hatcheries.

Disadvantages of this system includes long trucking distances to the Wenatchee and Methow, potential for spreading diseases to mid-Columbia watersheds, and decreased adult return rates expected from traditional concrete raceway rearing systems. The main advantage is that that large capital construction expenses are not incurred. Existing hatcheries also have secure water rights, experienced staff, completed construction and operating permits, known disease histories, and well-tested components.

Table 2. Hypothetical Rearing System – Existing Hatcheries

	Facility Example	Production (#)	Capital Cost	Operating Cost
Wenatchee	Willard NFH	1,000,000	$ -	$ 320,000
Methow	Winthrop NFH	300,000	$ -	$ 186,000
	Cascade NFH	700,000	$ -	$ 262,000
TOTAL		**2,000,000**	**$ -**	**$ 768,000**

b. New, Central, Conventional Hatchery

The second type of rearing system considered is construction of a single, large hatchery that would be capable of rearing over 2,000,000 coho. Water requirements generally limit locations to major rivers in the region with enough minimum flow to allow the withdrawal of over 45 cfs.

Eggs from brood stock captured in the watersheds would be hatched and reared to pre-smolt at this facility. The pre-smolts would be trucked to acclimation sites for final rearing and release.

For purposes of developing costs, standard hatchery designs are used for the estimates. Egg incubation in vertical stack incubators, first feeding in high density fry tanks, and rearing in concrete raceways are assumed. Both ground and surface water supplies are included. It is likely that both water supplies would need to be pumped. Reliable back-up power supplies and alarm systems are part of the cost estimates.

Advantages of this rearing system include reduced operating costs resulting from economies of scale, simplified management and control, reduced trucking distances, and new construction that incorporates the latest hatchery designs. Disadvantages include high construction costs, the risk of rearing all the valuable, locally adapted stock at one location; the difficulty of developing large ground water supplies; and the concentration of hatchery environmental impacts in one location.

Table 3. Hypothetical Rearing System - Large Central Hatchery

	Facility Example	Production (#)	Capital Cost	Operating Cost
TOTAL	Dryden	**2,000,000**	**$ 21,050,000**	**$ 512,000**

c. Multiple Small, Watershed Rearing Facilities

Small rearing facilities in each watershed could be developed to meet the production requirement in that area. This system has several drawbacks; including the difficulty of developing multiple water supplies that can reliably function year-round, the cost of obtaining long-term leases or ownership of multiple properties, and high operating costs due to multiple hatchery locations. Advantages to multiple small facilities includes: rearing near the release locations may increase homing fidelity, trucking distances and resulting stress is reduced, risk of loss is lessened by rearing fish in multiple locations, and the spread of disease between watersheds is minimized.

Table 4. Hypothetical Rearing System – Multiple Small Watershed Rearing Facilities

	Facility Example	Production (#)	Capital Cost	Operating Cost
Wenatchee	Dryden	500,000	$ 9,100,000	$ 224,000
	Chiwawa	500,000	$ 9,100,000	$ 224,000
Methow	Heath Ranch	500,000	$ 9,100,000	$ 224,000
	Poorman	500,000	$ 9,100,000	$ 224,000
TOTAL		**2,000,000**	**$ 36,400,000**	**$ 896,000**

d. Natural Habitat Rearing Facility

This production concept uses constructed, natural habitats as primary rearing units. Multiple habitats covering a large area are included at a single, central, rearing facility. Fingerlings or pre-smolts produced are trucked to acclimation sites.

Rearing habitats would be similar to those described below in Section f., CONSTRUCTED HABITAT. However, the facility would include adult holding, egg hatching, and raceway first-feeding as optional functions. Pre-smolt collection structures, predation controls, automatic feeding systems, and effluent treatment are also important features.

This is a new production concept that has not been fully tested. Design details have not been developed and the return rate benefit that is assumed for smolts produced in such a facility has not been demonstrated.

Table 5. Hypothetical Rearing System – Natural Habitat Rearing Facility

	Facility Example	Production (#)	Capital Cost	Operating Cost
TOTAL	Unknown	**2,000,000**	**$ 16,200,000**	**$ 512,000**

e. Long-Term Rearing at Acclimation Sites

Extended rearing (from fry to smolt) could occur at selected acclimation sites, reducing hatchery rearing capacity requirements. In order for acclimation sites to operate for 10-12 months, they would need to have dependable water supplies. High flow requirements during late summer/fall and icing conditions in winter complicate this type of rearing system. Gravity flow spring water or surface supplies with pumped groundwater back-up are supply options.

Advantages include rearing in a natural environment for a long period to time, the elimination of fish transport stress, possible improved homing fidelity, and low construction cost. However, the difficulty of operating sites in remote areas makes this an option that needs close scrutiny during evaluation.

Fish would be transferred into the acclimation sites after tagging in June, after rearing in a conventional hatchery. The costs below include both early hatchery rearing and grow-out in the acclimation ponds. A hypothetical program that releases fish from 20 different locations is used to develop the following cost estimate.

Table 6. Hypothetical Rearing System – Long-Term Rearing at Acclimation Sites

	Facility	Production (#)	Capital Cost	Operating Cost
Wenatchee	Various	1,000,000	$ 8,000,000	$ 464,000
Methow	Various	1,000,000	$ 8,000,000	$ 464,000
TOTAL		**2,000,000**	**$ 16,000,000**	**$ 928,000**

f. Constructed Habitat

Constructed habitat is a rearing environment that mimics ideal natural conditions. Key differences between constructed habitat and natural habitat include controlled predation, higher densities, artificial feed, and restricted migration out of the system. The differences allow higher smolt production rates per unit of area than natural environments.

These habitats consist of constructed pools, runs, riffles, alcoves, and ponds. Additional features include strategic placement of woody debris and overhead cover. Controlled water flow can be supplied by existing springs, by gravity flow intakes on surface streams, or by pumped wells. Eyed-eggs or fed fry are planted in the habitat and reared to sizes up to full smolt.

Smith et al. (2004) describe a test of a constructed rearing habitat using these concepts with coho on the Dungeness River. Migrating fish produced in the system exhibited wild-like behavior and appearance. 7,300 ft^2 of habitat was constructed and stocked with 50,000 eggs, producing 3,000 smolts after most fish migrated out as fry. By controlling fry migrations out of the habitat, recommended smolt densities have been increased to $0.5/ft^2$.

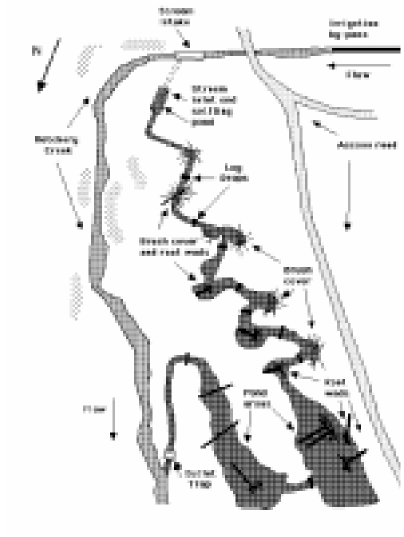

Figure 1. Constructed Habitat Example

Spawning habitat could also be included in the constructed system. The low gradient, small stream conditions that coho prefer for spawning could be duplicated. Fry produced in the system that exceed the capacity of the constructed habitat could be allowed to migrate out after emergence and seed existing natural rearing habitat in the area. Constructed spawning habitat could result in a significant quantity of naturally produced fry in a watershed and be used by other natural anadromous juveniles that volitionally migrate in for freshwater rearing.

The main advantage of constructed habitat is that it produces fish with "wild-like" behavior and characteristics. Adult return rates are expected to be high for such fish. These habitats will also double as acclimation sites. However, the concept has not yet completed long-term evaluation. A demonstration project in the Yakima subbasin with coho is planned to test the constructed habitat system in the Columbia watershed. Also, used on a large scale, multiple sites with reliable water supplies in upstream habitat will need to be located.

For fish that are not produced in the system through natural spawning, fry would be planted into the habitat after tagging in June. This avoids some of the high mortality that fry in less controlled environments will encounter. Until that time, early rearing occurs in raceways in a conventional hatchery. Therefore, the costs below reflect both the early hatchery rearing and grow out in the constructed habitat for the entire production program.

Table 7. Hypothetical Rearing System – Constructed Habitat

	Facility	Production (#)	Capital Cost	Operating Cost
Wenatchee	Various	1,000,000	9,000,000	$ 400,000
Methow	Various	1,000,000	9,000,000	$ 400,000
TOTAL		**2,000,000**	**$ 18,000,000**	**$ 800,000**

g. Other Methods

Private contract growers offer another rearing option. Reduced cost is the main advantage; there would be no capital costs charged to the programs for existing hatcheries that do not need modification. Operating costs could also be lower. One such option is the Troutlodge Hatchery at Winchester, WA about 40 miles from Wenatchee and 135 miles from Winthrop. Troutlodge is a gravity flow, spring water facility that could be devoted completely to coho production. However, the 13 C constant water temperature may not produce pre-smolts of optimum quality because of the lack of seasonal temperature regimes (see Appendix A).

Planting adults or fry into the existing habitat could be a replacement for artificial production. Coho fry plants in the Yakima were not successful in the past, with the notable exception of originating a natural run in Ahtanum Creek. Adult plants have not yet been fully evaluated in the region but tests have begun in the Yakima and Wenatchee watersheds. For both adult and fry plants, high mortality during fresh water rearing limits their practicality. However, adult and/or fry plants may be useful in isolated circumstances. For example, excess adults that return to broodstock development release sites (the Icicle on the Wenatchee and Winthrop NFH on the Methow) could be transported to appropriate spawning habitat.

Another option is mining eyed eggs from stream redds, full life history rearing in a hatchery, and then planting the adults back in targeted streams. This has shown some promise in helping with salmonid recovery efforts in Hood Canal (Berejikian et al., in press).

2. System Comparison Summary

The operating and capital costs of the described rearing systems are summarized in the table below. The operating cost is converted to a net present value (using and assumed long-term rate of inflation of 3%) for comparison purposes. A project life of 20 years is assumed in this calculation. The last column is the total of the capital cost and the present value of the operating cost.

Table 8. Rearing System Cost Comparison

PRODUCTION SYSTEM OPTIONS	CAPITAL COST	ANNUAL OPERATING	PRESENT VALUE OF OP. COST	TOTAL PRESENT VALUE
EXISTING HATCHERIES	$0	$768,000	$11,400,000	**$11,400,000**
CENTRAL, CONVENTIONAL HATCHERY	$21,050,000	$512,000	$7,600,000	**$28,650,000**
SMALL WATERSHED REARING FACILITIES	$36,400,000	$896,000	$13,300,000	**$49,700,000**
NATURAL HABITAT REARING FACILITY	$16,200,000	$512,000	$7,600,000	**$23,800,000**
LONG TERM REARING AT ACCLIMATION SITES	$16,000,000	$928,000	$13,800,000	**$29,800,000**
CONSTRUCTED HABITAT	$18,000,000	$800,000	$11,900,000	**$29,900,000**

The differences in operating costs reflect the higher expense of producing fish from multiple locations. There is a certain fixed base cost associated with operating a facility that is independent of the numbers of fish produced. The calculation of the present value of the operating costs demonstrate that the difference between producing all the fish at one location versus at multiple locations may be over $6,000,000 over a 20 year period. Differences in capital cost are the result both of the number of locations constructed and the complexity of the facilities.

This analysis shows that the alternative of using existing hatcheries has a much lower overall cost than the other options. It has no capital cost and a moderate operating cost. Multiple, small, watershed hatcheries have a very high total cost; all the other options are intermediate.

As discussed in Section III, SITING AND DESIGN GUIDELINES, important factors used to evaluate rearing system options include the ability to produce fish that return to targeted areas at high survival rates, along with other evaluation criteria discussed below. Table 9 summarizes the discussion of the production options. The Good, Fair, and Poor ratings are described in detail in Attachment 2, SITE COMPARISON KEY.

Table 9. Comparison of Production System Options

PRODUCTION SYSTEM OPTIONS	ADULT SURVIVAL RATE	COST	OTHER CRITERIA
EXISTING HATCHERIES	Poor	Good	Fair
CENTRAL, CONVENTIONAL HATCHERY	Poor	Fair	Fair
SMALL WATERSHED REARING FACILITIES	Fair	Poor	Fair
CENTRAL, NATURAL HABITAT REARING FACILITY	Good	Fair	Poor
LONG-TERM REARING AT ACCLIMATION SITES	Good	Fair	Poor
ENGINEERED HABITAT	Good	Fair	Poor

The degree of difference between the various systems' adult survival rates is unknown. However, published literature includes enough detail to allow the determination of which systems are likely to be the most successful (see Appendix A for more detail). Adult return rates are expected to be impacted by the type and length of acclimation. Long acclimation periods in natural conditions will improve the performance of fish produced from conventional hatcheries (see Appendix B.2).

The "other criteria" used in the table include:

- Adaptability to changing production technology. Can the rearing system be changed to match new production and acclimation methods?

- Adaptability to changes in program design. Can the rearing system capacity be expanded or reduced as changes in production numbers occur due to program adaptation?
- Environmental impacts. Are there significant impacts? All rearing systems must meet permit conditions, which assures that there will be a limit to the level of environmental impact.
- Program risk management. Will fish losses due to facility failures or transfer interruptions due to disease outbreaks be catastrophic to the program?
- Operational considerations. Is the system difficult to manage and operate? Long distance hauling of fish, multiple rearing sites, and locations in areas with access problems are system operating considerations.

None of the systems were rated “good” in the “other criteria” category. Each has characteristics, discussed above, that prevent it from being ideal. Long-term rearing at acclimation sites and constructed habitat are rated poor because of the potential difficulty of operating multiple sites in upstream areas through the winter.

Conclusions can be drawn through this comparison of rearing system alternatives. The central, conventional hatchery and the small, watershed rearing facility systems did not have any “good” ratings. Also, the natural habitat rearing facility is an untested concept. These three alternatives will not be part of the proposed rearing plan.

Of the remaining options each has benefits. Existing hatcheries have a very low program cost. Constructed habitats and long-term rearing at acclimation sites will produce smolts with increased survival rates. These two options will be included in the proposed rearing system; sites are proposed in Chapter V.

B. IDENTIFIED SITES

Identification of specific potential rearing sites began with a review of existing literature. There have been several notable, thorough searches for fish hatchery sites in the Mid-Columbia region, including: Bugert, 1996; Senn, 1987; and Frederikson and Kamine & Associates, Inc., 1981; and Delarm, 1990. Other documents also provided insight into site identification and are listed in these references. Some literature reviews have concluded that the availability of new ground water supplies for major hatchery construction is limited in the Columbia basin.

Site visits are an ongoing step in the identification process. Information about water supplies, presence of wetlands, flooding risks, current land use, construction layout, access, and utilities is collected during these visits. This information is integrated with reviewed document and from discussions with regional experts to supply data needed to make rearing site location decisions.

A full list of all identified sites is included in Attachment 3, SITE LIST. Following is a discussion of the high priority sites from that list and a map showing their location.

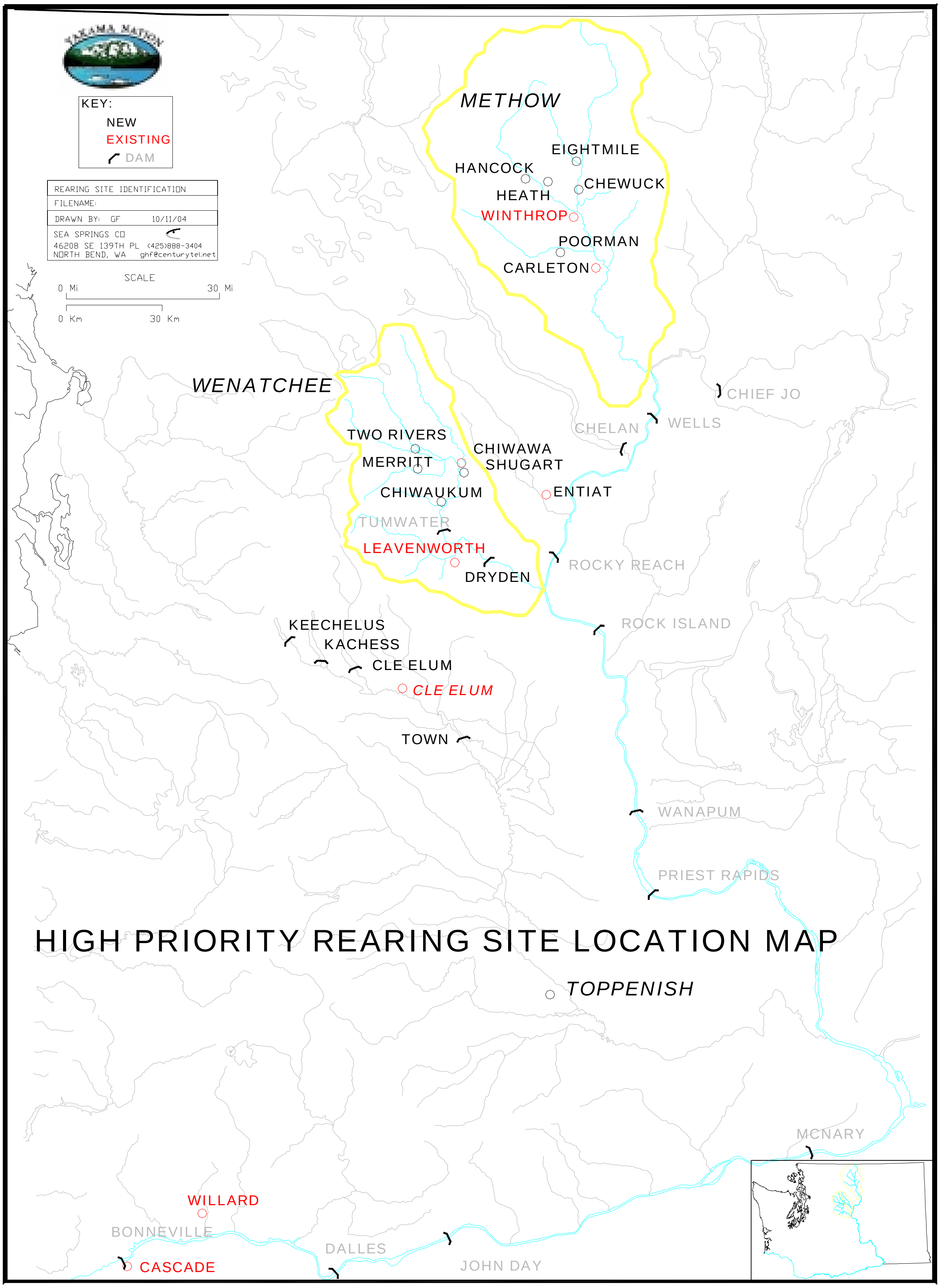

Figure 2. High Priority Rearing Site Map

1. Existing Rearing Facilities

a. YN Hatcheries

Cle Elum FH (YKFP). Operates on pumped well and Yakima River water (water rights of 25 cfs surface and 17 cfs ground). Designed to produce 810,000 spring chinook smolts at 15/lb. Well water is 100% used for the high priority spring chinook program during spring and summer. An infiltration gallery near the Yakima River, additional surface water rights, and/or re-use water could allow coho expansion.

b. USFWS Hatcheries

Leavenworth NFH. Currently used for acclimating coho for the mid-Columbia program, with a capacity of 600,000 smolts held in re-use water. Supply is a combination of surface and well water. New water development opportunities are limited. The possibility of a full rearing program in old concrete raceways exists using re-use water. Leavenworth NFH produces 1.7 million spring chinook smolts, total water rights of 57 cfs from Icicle Creek and wells.

Winthrop NFH. Currently used for rearing coho for the mid-Columbia program, with a capacity of 250,000 smolts. New water development opportunities are limited. Winthrop NFH also produces 600,000 spring chinook and 100,000 summer steelhead; total water rights of 66 cfs from the Methow, springs, and infiltration galleries.

Entiat NFH. Currently used for holding and spawning adult coho for the mid-Columbia program. Continued use of the hatchery for the MCCRP is dependant upon programmatic changes currently under consideration. Under current operating plans there is limited water available for additional rearing. Production goals are 400,000 yearling and 400,000 sub-yearling spring chinook; total water rights are 34 cfs from the Entiat River, Packwood Springs, and wells.

c. Mitchell Act Hatcheries

Cascade FH (ODFW). Currently rearing 700K coho pre-smolts for the Mid-Columbia and 1.0M for the Umatilla coho programs. Capacity of 1.7 million coho smolts, with a water right of 44 cfs (actual use is less) from Eagle Creek. Each of the 30 concrete raceways are 78’ long by 15’ wide by 4’ deep. There is no ground water at the facility. Summer water temperatures are high. Predator covers have recently been installed to reduce predation and improve rearing conditions. Eagle Creek has a highly fluctuating temperature profile (see plot below) which may be beneficial for smolt quality (see Appendix A. CULTURING GUIDELINES). Cascade FH is a Mitchell Act funded facility; current coho production costs are not charged to the Yakama Nation.

Willard NFH (USFWS). Currently rearing 600K coho pre-smolts for the mid-Columbia program. Shade covers have been recently installed over the raceways to improve rearing conditions. The Little White Salmon River provides surface water which is heavily ground water influenced. Flow rates are stable and relatively high through the summer and fall periods. Each of the 50 small concrete raceways measures 72’ long by 8’ wide, by 2’ deep. Reduced temperature fluctuation due to ground water influence may reduce smolt quality since it moderates natural seasonal variation (see plot below). Willard NFH as a capacity of 2.5 million coho smolts, and water use of up to 54 cfs.

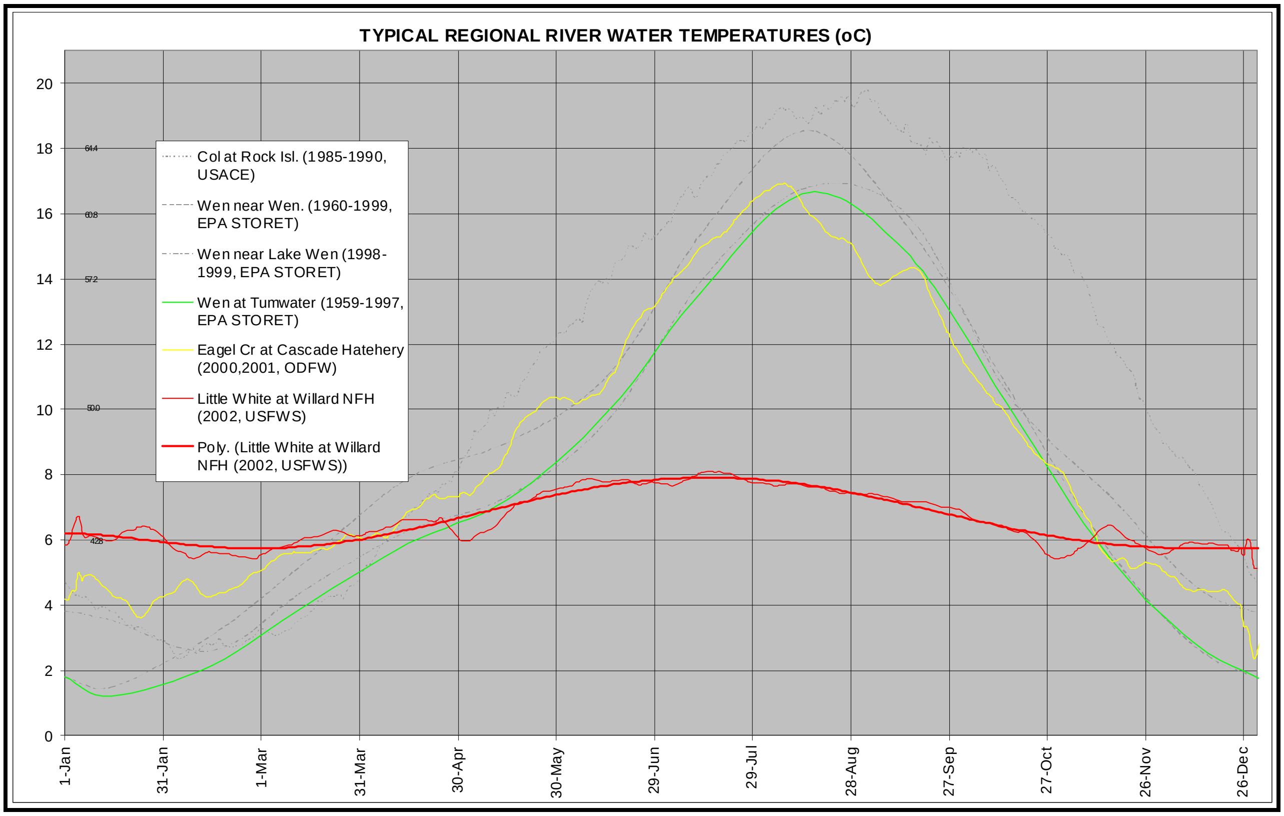

Figure 3. Water Temperatures

d. Acclimation Sites

Existing acclimation sites being used by other programs in the region may have potential to be expanded into yearling rearing facilities. Ground water supplies would need to be developed at most existing acclimation sites to add necessary winter water supply security and flexibility:

Carleton Acc. Site (WDFW). Summer chinook acclimation facility. The Carlton Acclimation Site has a moderately good intake on the Methow (15 cfs) which supplies surface water. High summer river temperatures, and low flow/winter icing conditions at the intake may be problems. Ground water development potential is untested.

Chiwawa Acc. Site (WDFW). Spring chinook acclimation facility. Dual surface water intakes exist on the Wenatchee (12 cfs max) and Chiwawa (21 cfs). The Wenatchee intake is high quality, located in a deep pool at a site that has minimal winter icing. Cold winter temperatures limit the use of the Chiwawa intake but the icing issue at the Chiwawa intake is currently being addressed and remedied by Chelan PUD (facility owner) and WDFW (facility operator) . Local geology indicates that large groundwater withdrawals from the shallow Chiwawa alluvial fan may be possible, but test wells in the area were not highly productive.

2. New Rearing Facility Sites

a. At Existing Dams

Facilities built near dams have several advantages as potential rearing locations:

- Reservoir pools make good intake locations, usable in all flow conditions.
- Water temperature control may be possible at larger dams by varying the intake depth.
- Gravity flow supplies are possible at some locations.

- Water rights issues are minimized when water is returned to the base of the dam, allowing large withdrawals.
- Water heads created by the impoundments can allow facilities built downstream to be above flood elevations.
- Some dams have a potential source of groundwater supply with seepage under and around the structure. This “toe drain” water is sometimes collected into accessible locations.

A potential disadvantage is the loss of water when dam reservoirs are drained for maintenance.

Potential sites include:

Cle Elum Dam. Moderate head irrigation diversion dam on Cle Elum R. Toe drain water may be an option for a second source.

Dryden Dam. Low head irrigation diversion dam on Wenatchee. Groundwater potential is untested but infiltration galleries may be productive due to the Peshastin Creek alluvial fan. Proximity of other wells may preclude deep water withdrawals. The dam produces good conditions for a surface water intake on the Wenatchee River. Warm summer temperatures and icing conditions in winter may be problems. Wenatchee stock coho adults are trapped at Dryden Dam so adult transport would be minimized. The potential site is owned by the Washington State Department of Transportation and a private orchard.

Kachess Dam. Moderate head irrigation storage dam on Kachess R. Toe drain water may be an option for a second source.

Keechelus Dam. Moderate head irrigation storage dam on Yakima. Toe drain water is an option for a second source. Keechelus Dam is being rebuilt; toe drain flows will likely be reduced.

Town Dam. Low head irrigation dam on Yakima. Well field exists near the site.

b. Other

These sites currently are undeveloped and were not used during the feasibility phase of this project. They all have surface water and either existing springs or some potential for developing ground water.

Chewuch. On the lower Chewuch River, a Methow tributary. Groundwater study evaluations have not been conducted. Private ownership.

Chiwaukum. On the Wenatchee River near the mouth of Chiwaukum Creek. Groundwater study evaluations have not been conducted but development potential exists. Conditions for a river intake are moderate to poor. Public ownership.

Eightmile. On the Chewuch, a Methow River tributary. Wells exist. USFS ownership, Eightmile Ranch.

Hancock Spring. Springs on the Methow River upstream of Winthrop. Valuable habitat created by spring flow. Conditions for a river intake near the springs are poor. Private ownership.

Heath Ranch. Springs on the Methow River upstream of Winthrop. Spring water and a surface water intake on the Methow are possible water sources. Conditions for a river intake in the area are poor. High flood risk. Private ownership.

Merritt. On Nason Creek (Wenatchee Basin). Groundwater potential is untested. Private ownership.

Poorman. On the lower Twisp (Methow Basin). Groundwater study evaluations have not been done. Private ownership.

Shugart Flat. Undeveloped site on the Wenatchee River downstream of the Chiwawa River confluence. Groundwater study (GeoEngineers, 2000) identified this site as having potential. Conditions for a river intake are moderate. Private ownership.

Two Rivers. Undeveloped site between the White and the Little Wenatchee near their mouths. A ground water study and pump test (GeoEngineers, 2003) at the nearby Two Rivers site demonstrated the potential for development of large groundwater supplies. Pumped White River or Little Wenatchee River water could also be used. The area is subject to flooding from the Little Wenatchee and White Rivers. Private ownership.

3. Site Comparison Summary

Table 10 below compares the high priority sites. It allows a general picture of the benefits and drawbacks of sites to be viewed using all the identified criteria. The comparison guidelines are described in Section III The key that defines the Good, Fair, and Poor ratings is in Attachment 2.

Table 10. Site Comparison

Site	Cle Elum FH	Leavenworth NFH	Entiat NFH	Cascade FH	Willard FH	Winthrop NFH	Butcher	Carleton Acc. Site	Chiwawa Acc. Site	Twisp	Cle Elum Dam	Dryden Dam	Kachess Dam	Keechelus Dam	Chewuck	Chiwaukum	Eightmile	Hancock Spring	Heath Ranch	Merritt	Poorman	Schugart Flat	Lake Wenatchee
Site Type	EXISTING HATCHERIES						EXISTING ACCLIMATION				DAMS				OTHER UNDEVELOPED SITES								
Rearing System (see key)	1	1	1	1	1	1	5,6	2,3,4	2,3,4	5,6	2,4	2,3,4	2,4	2,4	5,6	2,3,4	5,6	5,6	5.6	2,3,4	5,6	2,3,4	2,3,4
Effectiveness																							
Adult return rates	F	P	F	F	P	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Cost																							
Permits	F	G	G	G	G	F	F	F	F	F	P	P	P	P	P	P	P	P	P	P	P	P	P
Purchase/lease	G	F	F	F	F	F	F	F	F	F	P	P	P	P	P	P	P	G	P	P	P	P	P
Design and construction	F	G	F	G	G	G	F	G	G	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Operation	G	F	F	F	F	F	F	F	F	F	F	F	F	F	P	P	P	P	P	P	P	P	P
Other program functions	F	F	F	P	P	F	G	G	G	G	P	G	P	P	F	F	F	F	F	G	G	G	G
Water supply																							
Summer flow and temperature	G	G	G	F	P	F	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G	G
Second winter flow and temp	G	G	G	G	P	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Back-up supply	G	G	F	P	P	G	F	G	F	F	F	G	F	F	F	F	G	P	P	G	F	G	G
Water quality	G	P	G	G	G	G	G	F	G	G	G	F	G	G	F	G	G	G	G	G	G	G	G
Disease risk	P	P	F	P	P	F	F	F	F	F	P	F	P	P	G	G	G	G	G	G	G	G	G
Intake location	F	F	F	G	G	F	F	F	G	F	G	G	G	G	F	F	F	G	G	F	F	F	F
Flow volume stability	F	F	F	F	G	F	P	F	G	P	G	G	G	G	G	F	P	G	G	F	F	G	G
Expansion potential	P	P	P	P	F	P	P	F	G	P	G	G	G	G	F	F	P	P	F	G	F	G	G
Permitting/Impacts																							
Water rights	F	G	G	G	G	G	F	F	F	F	F	F	F	F	P	P	P	P	P	P	P	P	P
Endangered species	G	G	G	G	G	G	P	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Shorelines	G	G	G	G	G	G	F	G	G	F	F	F	F	F	F	F	F	F	F	F	F	F	P
Wetlands	G	G	G	G	G	G	P	G	G	P	G	G	G	G	G	G	F	F	P	F	F	F	F
Other	G	G	G	G	G	G	F	F	G	F	G	G	G	G	F	F	F	G	P	F	F	F	P
Operation																							
Space availability	G	P	G	P	P	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Flooding	G	G	G	F	G	G	P	F	F	P	G	P	G	G	F	F	F	F	P	F	F	F	F
Hauling distance	P	F	F	P	P	F	G	F	F	G	P	F	P	P	G	F	G	G	G	G	G	F	G
Other fish facilities	G	G	G	F	F	G	G	G	G	G	F	G	F	F	G	G	F	F	F	G	P	P	G
Adaptability	F	P	F	P	P	P	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Access	G	G	G	G	G	G	P	F	F	F	F	F	F	F	F	F	P	F	F	P	P	P	P
Site control	F	P	P	P	P	P	G	F	F	F	F	F	F	F	G	G	G	F	G	G	G	G	G

1 EXISTING HATCHERIES

2 CENTRAL, CONVENTIONAL HATCHERY

3 SMALL WATERSHED REARING FACILITIES

4 NATURAL HABITAT REARING FACILITY

5 LONG-TERM REARING AT ACCLIMATION SITES

6 ENGINEERED HABITAT

KEY: G = Good, F = Fair, P=Poor

As discussed in Section IV.A.2. SYSTEM COMPARISION SUMMARY, existing hatcheries, constructed habitat, and long-term rearing at acclimation sites are the preferred production systems. The site comparison summary above helps identify the preferred sites for those systems.

Cascade FH, Willard NFH, and Winthrop NFH are the proposed sites for the existing hatchery rearing system option. These hatcheries have similar ratings, existing rearing capacity, and were used during the feasibility phase of this project. First use water is available at all three facilities. Cascade FH has a surface water supply which we expect produces smolts with high return rates. Winthrop NFH is close to Methow acclimation sites. Willard NFH has a stable, high quality water supply and a cooperative staff but the constant temperature water may be a disadvantage.

The proposed constructed habitat sites are Eightmile and Heath Ranch. The proposed sites have relatively secure water supplies that can function year round. The sites may have available property and are both located near quality habitat.

Dryden was chosen as the preferred adult holding and incubation facility location based on attributes that result in a high rating as a new central or small, watershed hatchery. Many of the reasons that make Dryden useful for those rearing systems also make it useful for the adult and egg functions. Also, the site has the potential to expand into a full hatchery at some point in the future if needed.

V. *PROPOSED REARING PLAN*

A. PLAN DESCRIPTION

The alternative rearing systems were compared in section IV.A.2 and specific sites were compared in IV.B.3. Using the results of those evaluations a proposed plan has been developed. It is a combination of rearing systems that makes extensive use of available production capacity, with 85% of all program fish being reared in existing hatcheries. The remainder would be produced in the constructed habitats in the Methow watershed.

The low adult return rates of fish produced from the conventional, existing hatcheries will be mitigated by acclimating fish in natural conditions. Where sites allow, program fish will be held at these acclimation locations through the winter. If over winter acclimation is not possible then fish will be acclimated 4-6 weeks until release. The acclimation plan is described in Appendix B.2.

The proposed MCCRP rearing plan is summarized in the table below. The 5 facilities identified for use are described in detail in Appendix C.1 and C.2.

Table 11. Proposed Rearing Plan

	Location	Type	Fish
Wenatchee	Cascade	Existing Hatchery	250,000
	Willard	Existing Hatchery	905,000
Methow	Eightmile	Constructed Habitat	200,000
	Heath Ranch	Constructed Habitat	100,000
	Cascade	Existing Hatchery	450,000
	Winthrop	Existing Hatchery	250,000
TOTAL			**2,155,000**

The Methow presents unique challenges to the goal of developing a naturally spawning coho population. The long migration path through 9 mainstem dams results in high downstream smolt mortality and upstream adult drop out. Maximizing adult survival rates and migration motivation is a priority to offset these impacts. The proposed constructed habitats at Eightmile and Heath Ranch are expected to produce smolts with the "wild" characteristics that result in high return rates. Cascade Fish Hatchery is a surface water facility that is expected to produce quality coho smolts. Adult holding and spawning for the all Methow River production is planned for the Winthrop NFH, along with production of 250,000 pre-smolts.

All Wenatchee River fish will be produced at the Cascade and Willard hatcheries. Adults trapped in the Wenatchee watershed would be transported to the Dryden facility where they will be held for ripening and spawning. Eggs will be incubated to the eyed stage (500-600 temperature units) at Dryden and at the existing Peshastin incubation site. Eyed eggs from the proposed Dryden facility would be shipped to Cascade and Willard for rearing.

A new, adult holding and incubation facility is necessary because the Entiat NFH, where Wenatchee adult coho are currently held, will not be available in the future; other hatcheries in the region do not have the capacity for coho holding and spawning. The proposed Dryden facility gives MCCRP managers control over important parts of the fish culture program, is centrally located within the project area, and reduces the transfer of fish and gametes between watersheds.

This preferred production plan minimizes costs while still producing smolts that will achieve the program goal of helping create a coho population that will successfully spawn in the wild. The preferred plan makes efficient use of existing hatchery capacity, maintains program flexibility, minimizes risks, and, together with the acclimation program, will return adults to Wenatchee and Methow preferred habitat locations.

B. STEP 2 SITE EVALUATIONS

Future facility work supporting the Step 2 NPPC step review process will include the collection of the following data at the Dryden, Eightmile, Heath sites:

- Surface water intake conditions - channel stability, sweeping flows, and river stage/discharge data.
- Surface water flow, temperature, and quality.
- Surface water withdrawal impacts.
- 100 year flood elevations.
- Ground water availability - quantity and depth.
- Ground water temperature and quality.
- Ground water withdrawal impacts - nearby well locations.
- Land ownership and property boundaries.
- Zoning.
- Topographic data.
- Environmental land conditions and previous uses.
- Cultural resources.
- Critical habitat.
- Utilities and access.

Selected sites may not be available for variety of reasons. As a result, alternative locations will be studied through the evaluation and permitting phases in parallel with the primary sites.

VI. ATTACHMENTS

1. REFERENCES

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2. SITE COMPARISON KEY

Effectiveness		
Adult return rates	Good	Return rates higher than other mid-Columbia hatcheries.
	Fair	Rates similar to other facilities.
	Poor	Rates lower than other facilities.
Cost		
Permits	Good	Most permits and environmental evaluations in place.
	Fair	Moderate cost and time to obtain permits.
	Poor	Long, complex permit application process.
Purchase/lease	Good	Immediately available site at no capital or lease cost.
	Fair	Moderate cost.
	Poor	High cost, long negotiations.
Design and construction	Good	Land and water supply conditions favorable for construction.
	Fair	Moderate site conditions.
	Poor	Difficult, expensive site conditions.
Operation	Good	Location allows low cost maintenance, administration, and operation.
	Fair	Moderate operating costs.
	Poor	Remote location, high pumping costs, high manpower reqrts, etc.
Other program functions	Good	Adult holding, incubation, full rearing, and acclimation are options.
	Fair	Acclimation and rearing are possible.
	Poor	Rearing only.
Water supply		
Summer flow and temperature	Good	Avg. daily high temps < 62 F and flows meet conservative criteria.
	Fair	Avg. daily high temps < 65 F and flows meet moderate criteria.
	Poor	Avg. daily high temps >65 F and flows do not meet moderate criteria.
Second winter flow and temp	Good	Avg. daily temps 33 - 40 F and flows meet conservative criteria.
	Fair	Avg. daily high temps 33-45 F and flows meet moderate criteria.
	Poor	Avg. daily high temps >45 F and flows do not meet moderate criteria.
Back-up supply	Good	100% of water requirement available both from surface and ground water.
	Fair	50% back-up from independent source.
	Poor	No independent back-up supply.
Water quality	Good	No current of future water quality problems.
	Fair	Minimal water quality problems.
	Poor	Low water quality now and in the future.
Disease risk	Good	Low disease water supply, export out of watershed not necessary.
	Fair	Non-reportable diseases present in the water supply.
	Poor	Exports out of watershed may be prevented by reportable diseases.
Intake location	Good	Stable channel, deep pool, high sweeping velocities.
	Fair	Two of the three intake conditions met.
	Poor	None of the intake conditions are met.
Flow volume stability	Good	Stable short /long-term volumes; flood debris, icing minimal; gravity flow.
	Fair	Flow volumes stable, flood debris and icing moderate.
	Poor	Volumes unreliable, high flood debris and icing, pumped supplies.
Expansion potential	Good	Double the current required quantity of quality water is available.
	Fair	50% of the current required quantity of quality water is available.
	Poor	No excess water.
Permitting/Impacts		
Water rights	Good	Water rights for hatchery use currently exist.
	Fair	Minimal problems encountered in obtaining rights.
	Poor	Withdrawals cause significant environmental impacts.
Endangered species	Good	No listed or threatened species are present.
	Fair	Species are in the surrounding area and impacts are indirect.
	Poor	Significant impacts.
Shorelines	Fair	No permit opposition.
	Poor	Some opposition.
	Fair	Long process with heavy opposition.
Wetlands	Good	No wetlands in the area.
	Fair	Minor wetland disturbances can be mitigated.
	Poor	Wetlands disturbances require large-scale mitigation.
Flooding	Good	Construction does not impact flood elevations.
	Fair	Minor impacts can be mitigated.
	Poor	Significant impacts to flood elevations.
Cultural resources	Good	Inventory completed and cultural resources not present.
	Fair	Minor resource impacts.
	Poor	Important resources expected.
Water discharge	Good	Discharge does not impact receiving waters.
	Fair	Moderate impacts.
	Poor	Significant impacts.
Local zoning codes	Good	Hatchery use allowed.
	Fair	Variances can be obtained.
	Poor	Use is not allowed and variances are complex.
Operation		
Space availability	Good	Space is adequate for low density rearing and future expansion.
	Fair	Space is adequate for low density rearing.

3. SITE LIST

	Type	Owner	Operator	Water Source
POTENTIAL REARING FACILITY SITES - EXISTING				
YN OPERATED FACILITIES				
Cle Elum	Existing hatchery	Yakama Nation	YKFP	Yakima R., wells
Marion Drain	Existing hatchery	Yakama Nation	YKFP	Marion Drain
Prosser	Existing hatchery	Yakama Nation	YKFP	Yakima R., wells
USFWS HATCHERIES				
Entiat	Existing hatchery	USFWS	USFWS	Entiat R., springs
Leavenworth	Existing hatchery	USFWS	USFWS	Icicle R., wells
Winthrop	Existing hatchery	USFWS	USFWS	Methow R., galleries
MITCHELL ACT HATCHERIES				
Abernathy	Existing hatchery		USFWS	
Beaver	Existing hatchery		WDFW	
Big Cr	Existing hatchery		ODFW	
Bonneville	Existing hatchery		ODFW	
Carson	Existing hatchery		USFWS	
Cascade	Existing hatchery		ODFW	
Clackamas	Existing hatchery		ODFW	
Eagle	Existing hatchery		USFWS	
Elochoman	Existing hatchery		WDFW	
Fallert Cr	Existing hatchery		WDFW	
Gnat Cr	Existing hatchery		ODFW	
Grays R.	Existing hatchery		WDFW	
Kalama Falls	Existing hatchery		WDFW	
Klaskanine	Existing hatchery		ODFW	
Klickitat	Existing hatchery		WDFW	
Little White Salmon	Existing hatchery		USFWS	
N Toutle	Existing hatchery		WDFW	
Oxbow/Herman	Existing hatchery		ODFW	
Ringold	Existing hatchery		WDFW	
Sandy	Existing hatchery		ODFW	
Skamania	Existing hatchery		WDFW	
Spring Cr	Existing hatchery		USFWS	
Stayton Pond	Existing hatchery		ODFW	
Washougal	Existing hatchery		WDFW	
Willard	Existing hatchery		USFWS	
EXISTING ACCLIMATION SITES				
Beaver	Acclimation site	Private	YN	
Carleton	Acclimation site	Douglas PUD	WDFW	
Chewuch	Acclimation site	Douglas PUD	WDFW	
Chiwawa	Acclimation site	Chelan PUD	WDFW	
Dam 5	Acclimation site	Private/USFWS	YN	
Dryden	Acclimation site	Chelan PUD	WDFW	
Mahar	Acclimation site	Private	YN	
Twisp	Acclimation site	Douglas PUD	WDFW	
Two Rivers	Acclimation site	Private	YN	
OTHER EXISTING HATCHERIES				
Gloyd Springs	Existing hatchery	Grant PUD	Grant PUD	
Winchester	Existing hatchery	Private	Troutlodgte	

POTENTIAL REARING FACILITY SITES - NEW				
DAMS				
Chelan	Power	Chelan County PUD	Chelan County PUD	Chelan
Cle Elum	Irrigation	USBOR	Kittitas Rec. District	Cle Elum
Chief Jo	Dam	USACE	Seattle District	Columbia
Cowiche DD	Irrigation diversion			Naches
Dryden	Irrigation diversion	Chelan County PUD	Chelan County PUD	Wenatchee
Easton DD	Irrigation diversion	USBOR	Kittitas Rec. District	Yakima
Kachess	Irrigation	USBOR	Kittitas Rec. District	Kachess
Keechelus	Irrigation	USBOR	Kittitas Rec. District	Yakima
Priest Rapids	Power	Grant County PUD	Grant County PUD	Columbia
Rock Island	Power	Chelan County PUD	Chelan County PUD	Columbia
Rocky Reach	Power	Chelan County PUD	Chelan County PUD	Columbia
Sunnyside DD	Irrigation diversion	USBOR	Sunnyside ID	Yakima
Town DD	Irrigation diversion	City of Ellensburg	City of Ellensburg	Yakima
Tumwater	Dam	Chelan County PUD	Chelan County PUD	Wenatchee
Wanapum	Power	Grant County PUD	Grant County PUD	Columbia
Wapato DD	Irrigation diversion	Wapato ID	BIA	Yakima
Wapatox DD	Dam	PacificCorps	Puget Power	Naches
Wells	Power	Douglas County PUD	Douglas County PUD	Columbia
OTHER NEW SITES				
Chewuck		Private		Ground, Methow
Hancock Spring		Private		Spring, Methow
Heath Ranch		Private		Springs, Methow
Mitchell Pit		Private		Ground, Methow
Nile Spring		Private		Spring, Naches
Pasco Springs		NMFS		Springs, Columbia
Poorman		Private		Springs, Methow
Shugart Flat		Private		Ground, Wenatchee
Toppenish		Private		Marion, Yakima, gournd
Unamed		Private		Spring, Klickitat
Yakima		Private		Springs
Waikiki Springs		WDFW		Springs, Spokane
White		Private		Ground, White

4. CAPITAL AND OPERATING COST BASIS

CAPITAL COSTS

EXISTING PUBLIC HATCHERIES

The hatcheries proposed for use have existing capacity and do not require significant capital expenses.

NEW, CONVENTIONAL HATCHERY

Construction costs of recent hatchery projects in the region are shown below. The values are updated to 2005 dollars by assuming an annual interest rate of 3% (the historic, average, effective rate). The water flow capacity of each facility is also shown.

HATCHERY	START OF OPERATION	2005 VALUE	CFS
Colville	1990	$6,400,000	13
Imnaha (est)	Future	$8,700,000	17.3
Merwin	1993	$9,500,000	11
Methow	1992	$10,800,000	28
Chief Jo	Future	$16,700,000	46

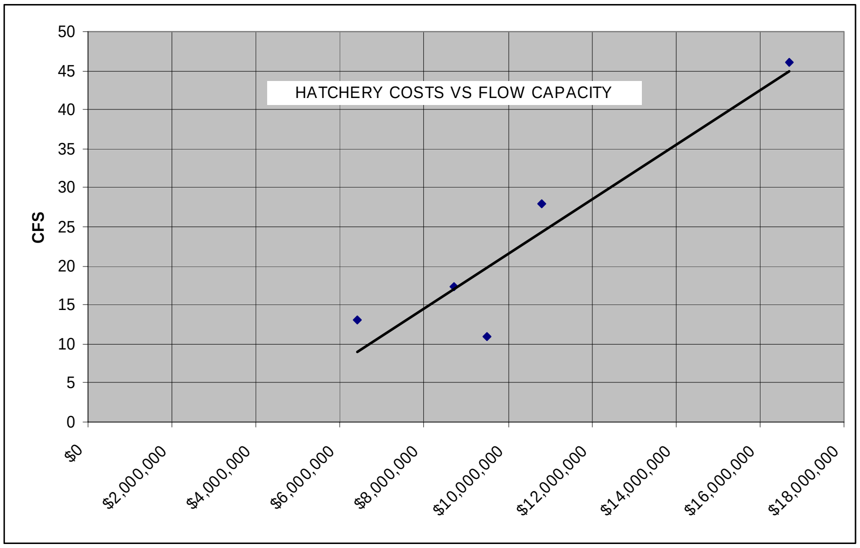
Hatchery details:

- The Colville Hatchery is operated by the Confederated Tribes of the Colville Reservation (CTCR) and produces 50,000 lbs of trout per year. It has 13 cfs of pumped ground water and no surface water capability.
- The Imnaha Hatchery is planned as part of the NE Oregon Hatchery Project. Expected capacity is 490,000 (24.500 lbs) spring chinook with a peak water use of 14.5 cfs.
- The Merwin Hatchery is operated by WDFW. It uses 11 cfs of gravity flow surface water from Merwin dam. Construction costs are relatively high due to the addition of an ozone water treatment system.
- The Methow Hatchery is a spring chinook facility operated by WDFW. It has 10 cfs of pumped ground an 18 cfs, gravity flow surface water right. The production capability is 550,000 smolts (62,000 lbs) per year.
- A new hatchery at the Chief Joseph dam is planned by the CTCR. The capacity is expected to be 145,000 lbs with a water flow of 46 cfs.

Each of these hatcheries have different production capabilities, different functions, and different site characteristics, which result in the wide range of construction costs. They are representative of the types of facilities that are proposed as new, central hatcheries.

Flow capacity is a design variable that is closely tied to facility construction cost. Fish production requirements set water flow rates and rearing volume capacity. As a result, flow is also a general measure of the physical size and cost of hatchery rearing facilities. Flow capacity is a more direct cost predictor than rearing volume because it determines the size of the water intake/supply system. Flow capacity will be the design variable used to develop a predictive formula for coho hatcheries of various sizes that is based on these other hatchery costs. The plot below shows the relationship between flow and cost, with a linear trend line included. The formula for this line is:

$$Cost = (Flow + 14.4) / (.0000036)$$



The above costs include capital construction expenses only. Other capital costs incurred during rearing facility development that are not included above are:

- *Environmental evaluation and permitting* (excluding NEPA and ESA): In their analysis of Pacific Northwest rearing facilities, Senn and Mack (1984) estimate the costs of hatchery permitting at 11% of construction costs. Estimates in the Northeast Oregon Hatchery Project (Ashe et al, 2000) for the Imnaha Hatchery are $100,000, or 1.3% of construction costs. An average of these values is assumed, 6% of construction costs.
- *Facility design, engineering, and construction management*: Senn and Mack (1984) estimate design costs at 23%. Estimates in the Chief Jo Master Plan (CTCR, 2004) are 18% and for the Imnaha Hatchery they are expected to be 6-12%. An average of these values is assumed, 17%.
- *Capital equipment*. Estimated for the Chief Jo hatchery to be 3.4%.
- *Land purchase*. Estimated for the Imnaha hatchery to be .7% to 2.9%.

These other capital total 28% of construction costs. The formula for hatchery capital costs then becomes:

Cost = [(Flow + 14.4) / (.0000036)] x 1.28

LONG-TERM REARING AT ACCLIMATION SITES

The construction costs for acclimation sites are discussed in Appendix B.2, ACCLIMATION FACILITIES ALTERNATIVES. Acclimation sites that can function for long-term rearing will require relatively high cost water systems such as pumped ground water supplies and predator control structures. However, the rearing unit design can be simple and the capacity of the sites will be less than those in the summary above. An average cost per site is assumed to be $800,000.

CONSTRUCTED HABITAT

The cost for 1.8 acres of new habitat for a project on the Dungeness River was estimated to be $220,000 (David Smith, S.P Cramer and Associates, personnel communication). This value includes design and permitting but does not include land purchase. It is estimated that these other costs would increase the total to $320,000, or $180,000 per acre. Constructed habitat is expected to produce 20,000 smolts per acre (Dave Smith, S.P Cramer and Associates, personal communication). Capital costs are then $9.00 per fish ($6 per fish without land purchase).

NATURAL HABITAT REARING FACILITY

Capital costs for a large facility using constructed natural habitat are assumed to be less than to those for constructed habitat. Land purchase costs and permits will be lower for the single site. Partially offsetting the cost reduction is the higher cost of the facilities. Smolt collection systems add complexity to the design. Costs are assumed to be 90% of those of constructed habitat, or $8.10 per fish.

OPERATING COSTS:

The annual operating expenses of existing hatcheries are used for estimating. Data from several public hatcheries are summarized below. Support services such as maintenance, administration, tagging, transportation, and pathology are included.

HATCHERY	DIRECT HATCH. OP.	SUPPORT	ANNUAL CAPITAL AT (5%)	TOTAL	YEAR OF EST.	2004 VALUE AT (3%)	YEARLY PROD. (LBS)	COST ($/lb)
Methow	$371,000		18,550	$ 389,550	1996	$ 493,000	62,000	$ 7.95
Willard	$310,000		15,500	$ 325,500	2005	$ 326,000	40,000	$ 8.15
Cascade	$588,000	$ 94,080	29,400	$ 711,480	2002	$ 777,000	147,000	$ 5.29
Klickitat	$517,000	$191,290	25,850	$ 734,140	2002	$ 802,000	170,000	$ 4.72
Eagle	$826,000		41,300	$ 867,300	2003	$ 920,000	180,000	$ 5.11

Hatcheries with high yearly production have lower per pound operating costs. After factoring in this production level impact and averaging the above values, it is assumed that the costs for 1,000,000 coho (40,000 lbs) will be $8/lb or $320,000 per year.

Scaling this amount for facilities that produce more or less than 1,000,000 coho will be done assuming that 40% of this cost does not change based on production and the other 60% changes ratiometrically. The unchanged portion estimates the fixed operating costs. The formula for calculating rearing site operating expenses for hatchery options is:

320,000*[.4+ 0.6*[(number of fish produced)/1,000,000]

Checks of the accuracy of this formula are that it matches the operating costs for current, full hatcheries and it also matches the amounts being paid by the MCCRP for partial operation of Willard Hatchery.

The options that do not involve full hatchery operation, long-term rearing at acclimation sites and constructed habitat, are expected to have higher production costs because multiple sites must be operated. The fixed costs per site will be lower, and formulas for them will be:

320,000*[(number of sites).05+ 0.95*[(number of fish produced)/1,000,000]